NEGATIVE PRESSURE GAS SAMPLING DEVICE

FIELD OF THE INVENTION

This invention relates to fluid sampling. More particularly this invention relates to fluid sampling for the detection of pollutants and contaminates.

BACKGROUND OF THE INVENTION

Environmental protection and health related issues have placed a special impetus on accurately taking samples from source emissions into the atmosphere, soil, and water. Analytes are typically tested at such low concentrations that even a small error in sampling can negate the validity of a sophisticated testing protocol. The design of collection vessels and devices used to fill those vessels contributes greatly to the validity of such procedures.

One vessel which has become widely accepted for use in this area is the "TEDLAR" bag (a tradename of the E. I. du Pont de Nemours Co., Inc.). In fact, it is presently the standard vessel for the sampling and analysis of source emissions. These bags have been found to be capable of collecting fluids containing any number of functional groups including hydrocarbons, halogenated organic moieties, alcohols, ketones, aldehydes, and aromatics. It is critical that the material used to collect and hold such samples not chemically react with the samples or matrix that contains the samples. This is generally the case with commercially available "TEDLAR" bags.

Selecting the appropriate sampling vessel also requires one to account for the proclivity of analyte to adsorb onto the vessel surface. This is predominantly a physical phenomena although it is not entirely divorced from the chemical reactivity of analyte and vessel surface. Analytes may adsorb onto the vessel surface by any number of well known phenomena and surface effects such as electrostatic attraction, London forces, etc. This is particularly troublesome where analyte concentration is low because some or all of the analyte may end up firmly affixed to the vessel surface. This could easily skew the results of an analysis of the vessel contents by several orders of magnitude.

Having decided upon the vessel to contain the sample, one next has to address how to collect and fill the vessel. This is a particularly important issue in ambient air monitoring where the analyte is in very small concentrations such as the low ppb (part per billion) range and cross contamination of sample is a concern. When the pressure of the fluid to be sampled is low, matters are further complicated by difficulties in transporting a fluid from a low pressure environment to a an environment at greater pressure.

One method adopted to overcome problems surrounding an awkward pressure gradient is through the employment of a negative pressure device. In such a device, a bag or other collapsible vessel is placed inside of an airtight container that has a passage way or conduit that connects the bag to the exterior of the container. The container is then evacuated by means of a pump. This induces a negative pressure or vacuum inside the container. The vessel is placed in communication with the environment from which one wishes to collect a sample. The vessel will fill with the sample as the pressure on both sides of the vessel equalize (provided the pressure inside the container is initially lower than the fluid pressure in the surrounding environment). U.S. Pat. No. 3,866,474 to Hasselmann is an example of such a device. It also incorporates an inert diluent gas.

While negative pressure sampling devices known in the art have solved many of the problems surrounding adverse pressure differentials, other difficulties continue to persist. In many cases, the only accurate or desirable place to sample fluid emissions is at their source. This is the case, for example, with many processes that vent byproduct or effluent through high velocity stacks. However, one who seeks to take a sample from such a stack will quickly realize that the negative pressure within the stack caused by rapidly exiting fluid makes negative pressure sampling very difficult. One must be able to create an intense vacuum within the container housing the sampling vessel to even fill the vessel. It would also be helpful if the device so employed was portable and remotable so that it could be placed in restrictive areas under harsh conditions. The device described in U.S. Pat. No. 3,866,474 for example, is only used to take samples at or near atmospheric pressure and is therefore inappropriate for use in this environment.

Another problem that is frequently encountered involves purging the sampling device and associated equipment of anything that is not sample. Generally, sampling devices have tubing, conduit, or other means of communicating between the inside of the vessel and the environment. This equipment is filled with air or whatever fluid the device is retained in. If an accurate sample is desired, this equipment and the contents of the vessel itself must first be purged of the surrounding fluid. This generally does not create a problem when the fluid purged or the sampling environment does not contain toxic or noxious contents. However, if this is not the case, those standing nearby can become exposed to danger when the sampling device is disconnected from the sampling line and its contents are purged. For example, it is not uncommon to place the inlet of a sampling device into an environment containing dangerous substances and fill the vessel. The inlet is then disconnected from the sampling line and it contents are purged into the same general environment in which the people taking the sample are found. When the vessel is completely purged it is then placed back onto the sampling line and a representative sample is collected. Obviously, this can be a dangerous undertaking.

Sampling an enclosed space which contains a limited quantity of fluid is also problematic with prior art methods. There are many instances in which one would like to withdraw a sample from such an environment without greatly disrupting the total pressure balance and fluid contents of that environment. Only the sample quantity is sought to be removed. This may be the case in certain environmental monitoring applications, off gassing of packaged products, and in applications such as in enclosed subterranean soil gas. If one were to employ prior art gas sampling methods they would introduce the inlet of a sampling device into the sampling environment and fill the vessel. The inlet is then removed from the sampling environment and the contents are expelled elsewhere while the lines of the device are purged. The inlet is then placed back into the sampling device and another sample is withdrawn. This can cause a tremendous pressure differential which can have a profound impact.

This type of problem can result in the structure surrounding the sampling environment giving way or in